
Automotive User Interfaces: Human Computer Interaction in the Car

**Albrecht Schmidt**

University of Duisburg-Essen
45127 Essen, Germany
albrecht.schmidt@acm.org

Anind K. Dey

Carnegie Mellon University
HCI Institute, 5000 Forbes Ave.
Pittsburgh, USA
anind@cs.cmu.edu

Andrew L. Kun

University of New Hampshire
Electrical and Computer
Engineering Department
Kingsbury Hall
Durham, NH 03824, USA
andrew.kun@unh.edu

Wolfgang Spiessl

BMW Group Research and
Technology
Hanauer Str. 46
80992 Munich, Germany
wolfgang.spiessl@bmw.de

Abstract

Cars have become complex interactive systems. Mechanical controls and electrical systems are transformed to the digital realm. It is common that drivers operate a vehicle and, at the same time, interact with a variety of devices and applications. Texting while driving, looking up an address for the navigation system, and taking a phone call are just some common examples that add value for the driver, but also increase the risk of driving. Novel interaction technologies create many opportunities for designing useful and attractive in-car user interfaces. With technologies that assist the user in driving, such as assistive cruise control and lane keeping, the user interface is essential to the way people perceive the driving experience. New means for user interface development and interaction design are required as the number of factors influencing the design space for automotive user interfaces is increasing. In comparison to other domains, a trial and error approach while the product is already in the market is not acceptable as the cost of failure may be fatal. User interface design in the automotive domain is relevant across many areas ranging from primary driving control, to assisted functions, to navigation, information services, entertainment and games.

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Introduction

Cars are more than individual means of transport and many people value their cars as personal spaces. In countries all over the world many people spend significant time in their cars while commuting to work. Besides the increased functionality offered to operate a car, vehicles have become a place for information access, communications, media consumption and personal entertainment. As most of the technology in the car is digital, cars have become interactive spaces and human factors play a central role in their design and the resulting user experience. In this Special Interest Group we follow up on the meeting in 2008 "All roads lead to CHI: interaction in the automobile" [1], a CHI SIG in Florence that attracted more than 60 people.

Over the last several years we have seen different trends that have severe implications on driving and on the user experience in the car:

- The use of mobile devices (e.g., smart phones) while driving (even though it is not allowed in many countries)
- Interaction with built-in information and entertainment systems

- Interaction with smart and autonomous functions in cars

Usability engineering, user experience and interaction design, and human factors face new challenges in this context. On the one hand, users are better supported by cars and they experience less effort in operating the car (e.g. assistance functionality, lane keeping, adaptive cruise control) and, on the other hand, they expect that they can perform more secondary tasks (e.g. phoning, email, looking up information, watching TV) while in the car. One of the central questions is how to design systems that make driving safer while providing for the users' needs. In addition to the technical challenges, we see that the design of in-car systems, which was historically the responsibility of car manufacturers and OEMs, is now a shared responsibility between a large and ever-changing group of parties. This group includes the car manufacturers and OEMs, but also the designers of devices that are brought in to the car, such as personal navigation devices and mp3 players.

Research and development of user interfaces in the automotive domain is in many ways different from desktop settings or mobile environments. Therefore we hope to start a discussion on methods, tools, and techniques for research in this area. Through this special interest group, we hope to bring together HCI researchers and industry representatives to discuss both the needs for improved and innovative interaction and interfaces in the car, and techniques for achieving these. Experts in human factors and HCI professionals have a long tradition in working in this field and we believe that their role is becoming more important with the increase of digital functionality in the car.



Mobile Devices in Use While Driving

Drivers interact with many devices while driving and these interactions might influence driving performance as well as visual attention. Unfortunately, without careful design, interactions with in-car devices will most likely make driving performance worse and will reduce visual attention on the road ahead. Examples of such outcomes abound. In various studies, researchers have shown the negative influence of interacting with police radios, mp3 players, personal navigation devices (PNDs) and many other devices. But, it is clear that interactions with these devices provide value to the user. For example police officers must be able to operate a police radio to perform their jobs and travelers value the information provided by PNDs. How can we design interactions with these devices such that they do not negatively influence driving performance and visual attention? More generally, how can we design the interactions such that they do not introduce a cognitive load that the driver cannot safely handle under the given driving conditions? Of course this latter question introduces yet another important one: what exactly is the relationship between increased cognitive load and driving safety? Finally, is there also an opportunity to go beyond simply eliminating the negative effects of in-car devices and design interfaces that will improve driving performance and visual attention and thus hopefully driving safety?

Interaction with Information and Entertainment in the Car

Car manufactures are adding more and more information and entertainment functionality in the car. Users can access information about the current status of the car (e.g., power efficiency and driving mode in a hybrid drive), sensory information collected by the car,

and information gathered over the Internet (e.g., weather and traffic information). With upcoming car-to-car communication technologies, the available information about the environment of the car (e.g., access to a camera in the car in front) will increase. Technically it is straightforward to receive a video stream from another car, but the questions of how the driver selects this view, how to present this to the driver and how the presentation and interaction will impact the driving performance are still open. We hope to start a discussion in the HCI community to look at these upcoming issues and to suggest solutions that make such technologies beneficial for the users.

Similar to the trend in information presentation we can observe an increase in entertainment functionality. Many car manufacturers offer sophisticated systems for media consumption for drivers and passengers ranging from audio presentation to Internet access, TV and games. Typically entertainment that needs visual attention is not provided for the driver while driving. However given the increase in smart systems that support the driver, we need to consider whether the safety and attentiveness of the drivers may even be improved when allowing a certain amount of entertainment that requires visual attention. Here, we expect that the experience of researchers in human factors can provide insights and ideas for new entertainment systems in the car.

Interaction with Smart Systems in the Car

Even if the driver is the only person in the car, she is not alone anymore. Since cars are increasingly equipped with advanced driver assistance systems (ADAS), drivers are not the only ones making decisions. ADAS are designed to assist drivers in many



Car User Interfaces. Photos taken at IAA 2007 by Dagmar Kern.

ways in order to make driving safer and more comfortable, e.g., by giving parking assistance, helping stay in a particular lane, maintaining a certain speed but keeping a safe distance to cars ahead, warning against various potential dangers, etc. Those systems can change the understanding of driving especially if the system takes over a certain driving task like maintaining the speed. The interaction with ADAS is often reduced to a purely functional aspect. Giving away control is always a matter of trust, though. When ADAS take over, drivers have to trust that what the car does is right. Following [3], low trust in an automated system, perhaps resulting from an earlier experience of failure, will probably lead to underutilization ('disuse'), however overestimating a system's capabilities can lead to 'misuse' and therefore potentially dangerous situations. The critical point is to design a smart system in a way that drivers understand the possibilities as well as the limits at all times. In the future we will possibly be confronted with cars that can drive completely autonomously in a certain situation, e.g., on a separate lane on the highway or in slow or congested traffic. However, there is still little known about how to design the user interfaces for such systems. Some of the questions are (the list is not intended to be exhaustive): how do you design the transition between automated, assisted, and manual driving, how can you represent the current system status unambiguously, how can you keep drivers supervising the system, how do you communicate failure?

Conclusion

The special interest group session seeks to bring together researchers, developers, practitioners and students from academia and industry who are concerned with envisioning, creating and implementing

automotive user interfaces. The session will provide a forum to discuss ideas and problems on the topic. We hope to jointly increase our understanding of the emerging design space of automotive interaction design and user interfaces. The overall aim is to foster a community that has interest and expertise in the domain of automotive user interfaces.

The dialog on automotive user interfaces is ongoing; there has been a SIG at CHI 2008 [1] and a conference in-cooperation with ACM SIGCHI (<http://auto-ui.org>) in 2009. The conference proceedings are available at [4]. A discussion of central issues that have been explored at the conference is provided in [5]. Interaction with cars is also an issue highlighted in Don Norman's latest book [2].

References

- [1] Krum, D. M., Faenger, J., Lathrop, B., Sison, J., and Lien, A. 2008. All roads lead to CHI: interaction in the automobile. In CHI '08 Extended Abstracts on Human Factors in Computing Systems (Florence, Italy, April 05 - 10, 2008). CHI '08. ACM, New York, NY, 2387-2390.
- [2] Norman, D. A. (2007). *The Design of Future Things*. New York: Basic Books. (November, 2007.)
- [3] Parasuraman, R., & Riley, V. (1997). Humans and automation: Use, misuse, disuse, abuse. *Human Factors*, 39 (2), S. 230-253.
- [4] Schmidt, A., Dey, A., Seder, T., Juhlin, O., 2009. Proceedings of the 1st International Conference on Automotive User Interfaces and Interactive Vehicular Applications, 2009. <http://portal.acm.org/toc.cfm?id=1620509>
- [5] Schmidt, A., Spiessl, W., Kern, D., 2010. Driving Automotive User Interface Research. *IEEE Pervasive Computing*, pp. 85-88, January-March, 2010